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Effects of Twin Separation in Primary School

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We studied the short- and long-term effects of classroom separation in twins on behavior problems and academic performance. Short-term effects were studied at age 7 in twins separated at age 5 and long-term effects at age 12 in twins who had been separated or together most of the time at school. Behavior problems were rated by mothers (Child Behavior Checklist at ages 3, 7 and 12) and teachers (Teacher Report Form at ages 7 and 12). Academic achievement was measured at age 12 using a national academic achievement test (CITO). At age 7, twins from separated pairs had more internalizing and externalizing problems than non-separated twins, as rated by both mothers and teachers. Only for the maternal ratings of internalizing problems, however, could these effects be attributed to the separation itself and not to preexisting problems (at age 3) between separated and non-separated twins. Long-term effects of separation were significant for maternal and teacher ratings of internalizing and externalizing problems, but these effects could be explained by preexisting differences between separated and non-separated groups. There were no differences in academic achievement between the separated and non-separated group. These results suggest that the decision to separate twins when they go to school is based in part on the existing behavioral problems of the twins and that, in the long run, separation does not affect problem behavior or academic achievement. The findings were the same for monozygotic and dizygotic twins.

In the Netherlands, the majority of children start primary school at the age of 4 (Statistics Netherlands, Centraal Bureau voor de Statistiek, n.d.) and this is when parents and teachers of twins decide whether or not to put the children into the same classroom. As there is hardly any research comparing the adjustment of twins who are separated versus those kept together at school, this decision is presently not evidence-based (Hay, 2004). The Dutch Society for Parents of Multiples (Nederlandse Vereniging voor Ouders van Meerlingen; NVOM) advises parents to base their decision whether or not to separate twins on what they think is best for their children, though generally

NVOM believes separation to be best for the individualization of the twins (Geluk & Hol, 2001).

Because of the importance of this question for parents of multiples, Tully et al. (2004) investigated the effects of classroom separation on twins' behavior, progress at school, and reading abilities. They studied a sample of 878 same-sex twin pairs from the United Kingdom (UK). The children were first assessed at the age of 5 years and were tested again approximately 18 months later. The assessment was done by the teacher and included externalizing and internalizing problems, prosocial behavior, Attention Deficit Hyperactivity Disorder symptoms, standard reading scores, how hard twins worked and how much they learned. The sample was divided into three groups: not separated (at both assessments twins were together in the same class, 552 pairs), separated early (twins were separated at age 5 and were still separated at the second assessment 18 months later, 162 pairs), and separated late (twins were together at the first assessment but had been separated by the second assessment 18 months later, 164 pairs). When compared with non-separated pairs, twins who were separated early had significantly more internalizing problems and twins separated later showed more internalizing problems and lower reading scores. Monozygotic (MZ) twins suffered more from separation than dizygotic (DZ) twins. Tully and colleagues did not find any effects on the other variables.

It is not known whether these UK findings generalize to other countries and cultures where the grounds for separation may differ. The Tully et al. (2004) results were based on teacher ratings of behavior at school. Behavior in the home situation, as rated by the parents, was not studied. The effects of separation on behavior were analyzed at ages 5 and 7, but no data were available at later ages. We carried out a replication study in a large sample of Dutch twins from the Netherlands Twin Registry (NTR), looking at behavior ratings from mothers and teachers and at a national test of academic achievement (CITO). As

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mother as well as teacher ratings are used in this study, information on the behavior of the twins at school as well as at home was collected. Looking at behavioral problems in the home as well as in the school situation may give a better understanding of the association between problem behavior and separation at school. Furthermore, we have information on problem behavior at the age of 3 years; problem behavior at an early age may be one of the reasons for parents and educators to separate the twins. We also could control for any differences in the twins' behavior before separation by including maternal ratings at age 3 into the analyses. We distinguished between the short- and long-term effects of separation on both maternal and teacher ratings. Short-term effects were defined as effects showing up at the age of 7 years as the result of separation at age 5, and long-term effect as effects showing up at the age of 12 years as the result of separation for the entire schooling up until that age. We concentrated on internalizing and externalizing problems. In addition, we looked at academic performance at age 12 using the CITO, a national test of educational achievement administered in the last grade of primary school in order to determine high school entrance level (Bartels et al., 2002). This study thus addresses the following questions:

- 1) Are there preexisting differences between twins who attend separate classes and twins who are in the same class when they enter primary school?
- 2) Are there any short-term effects of separation on maternal ratings of problem behavior at age 7, when controlling for preexisting differences?
- 3) Are there any short-term effects of separation on teacher ratings at age 7?
- 4) Are there any preexisting differences between twins who are in the same classes and those who are in different classes for their entire schooling?
- 5) Is there an effect of separation for the entire schooling on maternal ratings at age 12, when controlled for preexisting differences?
- 6) Is there an effect of separation at school on teacher ratings at age 12?
- 7) Is there an effect of separation at school on academic performance at age 12?

Like Tully et al. (2004), whether MZ and DZ twins differed in the way they reacted to separation was examined.

Method

Sample

All subjects were registered with the NTR, established by the Department of Biological Psychology at the Vrije Universiteit in Amsterdam. Around 40% to 50% of all multiple births in the Netherlands are registered by the NTR (Boomsma, 1998; Boomsma et al., 1992; Boomsma et al., 2002). Data of twins from the 1986–1996 birth cohorts were used in this study.

Surveys have been collected longitudinally at the ages of 1, 2, 3, 5, 7, 10 and 12 years. For this study, information from surveys collected at the ages of 3 and 5 years (completed by mothers), and 7 and 12 years (completed by mothers and teachers) was used.

Surveys sent out at the ages of 3, 7, 10 and 12 years contained the Child Behavior Checklist (CBCL; Achenbach, 1991a), to be filled out by both parents. All questionnaires were mailed within 3 months of the twins' birthday. Reminders were sent 2 to 3 months after the mailing and, if finances permitted, persistent nonresponders were contacted by phone 4 months after the initial mailing. Families for whom the addresses were no longer available were included in the nonresponse group. Response rates at ages 3, 7, 10 and 12 years were 72%, 66%, 64% and 64% respectively. (Note that if a family did not participate at a particular age, they were approached again for the next mailing. So a response rate of 66% at age 7 means that 66% of all the registered families with a twin pair that reached this particular age returned the questionnaire.) Teacher ratings were assessed using the Teacher Report Form (TRF; Achenbach, 1991b) and collected at ages 7, 10 and 12 years. After the parents' consent, the TRF was sent to the teachers of the twins. Response rates were 78%, 77% and 75% at age 7, 10 and 12 years respectively. The NTR only started collecting TRF data in 1999 so that TRF data collected at age 7 are not available for the 1986–1992 cohort.

The short- and long-term effects of separation were studied in two overlapping samples. For studying the short-term effect, questionnaires completed for twins of ages 3 to 7 years were available for 7595 twin pairs. Twin pairs were excluded when one or both twins had a disease or handicap at age 7 or younger that interfered severely with daily functioning ($N = 263$ pairs). Data from 594 pairs, of whom at least one twin received special education, were also excluded. So for short-term effects on maternal CBCL ratings, data from 6738 twin pairs were used for analysis. Short-term effects of separation on TRF ratings were studied in 5686 pairs.

For studying the long-term effects, data from 2359 twin pairs were available from which another 175 pairs were excluded as one or both children were attending special education, resulting in a sample of 2184 twin pairs. The long-term effects on TRF ratings were studied in 284 twin pairs. Academic achievement was measured in 843 twin pairs.

Zygosity was determined by DNA or blood group polymorphisms for 859 twin pairs. For the remaining same-sex pairs, zygosity was determined from questionnaire items (Rietveld et al., 2000).

Measures

Data on socioeconomic status (SES) from the survey mailed out when the twins were 3 years old were analyzed to address the question as to whether classroom separation is associated with SES. SES was based on a

full description of the occupation of the parents and classified using a 5-point scale, according to the system used by Statistics Netherlands (Fengler et al., 1997). The higher of the two parents' SES scores determined the SES of the twin pair.

Externalizing and internalizing problems were assessed with the two broad band scales of the CBCL/4–18 (Achenbach, 1991a; Verhulst et al., 1996) at the ages of 7 and 12 years, and the TRF (Achenbach, 1991b; Verhulst et al., 1997) at the ages of 7 and 12 years. The CBCL and TRF were developed for parents and teachers to score the behavioral and emotional problems of 4- to 18-year-old children. They consist of 120 and 118 items respectively, scored on a 3-point scale based on the occurrence of the behavior during the preceding 6 months. The internalizing scale consists of the Anxious/Depressed, Somatic Complaints and Withdrawn subscales. The Externalizing scale consists of the Aggressive and Rule Breaking Behavior subscales.

At the age of 3 years, the CBCL/2–3 (Achenbach, 1992; Koot et al., 1997) was used. The CBCL/2–3 is modeled on the CBCL/4–18 and consists of 99 items. The internalizing scale consists of the Anxious and the Withdrawn/Depressed subscales, and the externalizing scale consists of the Aggression, Oppositional and Overactive subscale.

Educational achievement was assessed by the Dutch CITO-elementary test. The CITO consists of 240 multiple-choice items assessing four different intellectual skills: Language, Mathematics, Information Processing and World Orientation. Each performance scale contains 60 multiple-choice questions. In 2001, the test was changed slightly with respect to the distribution of questions, resulting in 60 questions for Mathematics and World Orientation, 90 questions for Language, and 30 questions for Information Processing. Together, the performance scales result in a standardized score of between 501 and 550 (Bartels et al., 2002). In the surveys sent to the parents and teachers when the twins were 12 years of age, parents as well as teachers were asked to fill in this standardized score.

The questionnaires sent to the parents of twins at ages 5 and 12 years contained questions on whether the twins were in the same class. In the Netherlands, most children start primary school at the age of 4 years; compulsory education, however, starts at the age of 5 years. Nearly all children attend primary school for 8 years and go to secondary school at the age of 12 years. The separation of twin pairs can occur when children first start school or during primary school. When the twins were 5 years old, the parents were asked whether 'the twins are now a) together in the same school in the same classroom b) together in the same school but not in the same classroom and c) at different schools'. The answers were coded as *together* (same school, same classroom) and *separated* (different or same school, different classroom).

Parents of twins who were 12 years of age were asked 'which statement applies best to the school history of your twins a) same school, same classroom b) same school, parallel classes c) same school, different levels d) different schools e) partly same class, partly separated'. Answers were coded as *together* (same school, same classroom), *separated* (parallel class or different level or different school) and *partly* (partly same class, partly separated; there is no information about when and how long these twins were separated). At the ages of 5, 7, 10 and 12 years, mothers were asked whether the twins were in a school for special education.

Data Analysis

First we explored whether the percentage of the twin pairs separated at age 5 differed as a function of birth cohort and what percentage of twin pairs separated or together at the age of 5 years stayed separated or together. Next, the following analyses were performed to test the short- and long-term effects of separation on problem behavior and academic achievement:

- 1) To test whether separation at the age of 5 was associated with SES, internalizing and externalizing problems at the age of 3 years or within-twin pair differences in externalizing and internalizing problems at the age of 3 years, a logistic regression analysis was carried out. Separation at age 5 was the dependent variable and SES, internalizing and externalizing problems at age 3, and within-twin pair differences in externalizing and internalizing problems at age 3, were predictors.
- 2) To test the short-term effect of separation at the age of 5 years on internalizing and externalizing problems as rated by the mother, a MANOVA with repeated measures was carried out. The within-subject factor was age of testing (ages 3 and 7 years), the between-subject factor was separation of the twin pair at age 5 and the dependent variables were maternal CBCL internalizing and externalizing ratings at ages 3 and 7. We chose repeated-measures analysis to correct for any pre-existing differences between the separated and nonseparated twins. A main effect of separation indicates that there is an overall difference between children separated and children not separated. Such a difference may already exist before separation. Only when an interaction effect between the age of testing and separation is found, can the difference between separated and nonseparated twins be attributed to the separation.
- 3) To test the effect of separation at age 5 on internalizing and externalizing problems at age 7 as observed by the teacher, a MANOVA was carried out. TRF internalizing and externalizing problems at age 7 were the dependent variables, and separation at age 5 the between factor.
- 4) A multinomial regression analysis tested whether SES, preschool behavioral problems, or within-twin

Table 1

Number of Twin Pairs Together or Separated at Age 5 as a Function of SES

SES	Together	Separated
1 (lowest)	35 (66)	18 (34)
2	721 (74)	255 (26)
3	1612 (68)	762 (32)
4	765 (61)	486 (39)
5 (highest)	271 (57)	203 (43)
Total	3404 (66)	1724 (34)

Note: percentages in parentheses.

Table 2

Separation at Age 5 and Mean Untransformed and Uncorrected Maternal CBCL Ratings at Age 3 and 7 and TRF Ratings at Age 7

Measure	Separated at age 5	Zygosity	N	M (SD)
Internalizing problems age 3 mother	separated	DZ	1060	4.41 (3.81)
		MZ	636	4.75 (3.78)
		Total	1696	4.54 (3.81)
	together	DZ	2125	4.37 (3.70)
		MZ	1192	4.59 (3.85)
		Total	3317	4.45 (3.76)
Externalizing problems age 3 mother	separated	DZ	1059	15.77 (9.49)
		MZ	636	17.18 (10.35)
		Total	1695	16.30 (9.84)
	together	DZ	2124	15.18 (9.62)
		MZ	1190	15.54 (9.90)
		Total	3314	15.31 (9.72)
Internalizing problems age 7 mother	separated	DZ	1190	4.82 (4.61)
		MZ	728	5.09 (4.49)
		Total	1918	4.92 (4.57)
	together	DZ	2417	4.52 (4.49)
		MZ	1361	4.17 (4.23)
		Total	3778	4.39 (4.40)
Externalizing problems age 7 mother	separated	DZ	1211	7.81 (6.90)
		MZ	740	8.53 (7.08)
		Total	1951	8.08 (6.97)
	together	DZ	2453	7.24 (6.47)
		MZ	1382	7.21 (6.57)
		Total	3835	7.23 (6.50)
Internalizing problems age 7 teacher	separated	DZ	413	5.08 (5.40)
		MZ	273	4.49 (4.99)
		Total	686	4.85 (5.25)
	together	DZ	685	4.59 (5.23)
		MZ	365	3.42 (4.14)
		Total	1050	4.18 (4.91)
Externalizing problems age 7 teacher	separated	DZ	432	4.80 (7.67)
		MZ	287	4.28 (6.68)
		Total	719	4.59 (7.29)
	together	DZ	706	4.37 (7.00)
		MZ	370	3.53 (5.92)
		Total	1076	4.08 (6.66)

pair differences in problem behavior were associated with separation for their entire schooling. In this analysis, the dependent variable was separation (*together, separated or partly*), with *together* as the reference group and SES, problem behaviors at age 3, and within-twin pair differences in problem behavior as continuous predictors.

- 5) To test the long-term effect on problem behavior of attending school together or apart at the age of 12 years, a MANOVA with repeated measures was performed. The within-subject factor was the age of testing (3 years and 12 years) and the between-subject factor was separation for the entire schooling (*together, separated or partly*). Dependent variables were maternal CBCL internalizing and externalizing problems at age 3 and 12.
- 6) To test the effect of separation for the entire school period on teacher-rated problem behavior, a MANOVA was performed with TRF internalizing and externalizing ratings at age 12 as dependent variables and separation (*together, separated or partly*) as a between factor. Pair-wise comparisons were performed to see which of the three groups differed from each other.
- 7) To test the long-term effect of attending school together on academic achievement, an ANOVA was performed with the CITO scores as the dependent variable and separation as a between factor. Pair-wise comparisons were performed to see which of the three groups differed from each other.

If post hoc pair-wise comparisons were performed, Bonferroni correction for multiple testing was used.

As CBCL and TRF data were not normally distributed, scores were square-root transformed. After transformation, all skewness and kurtosis indices were between -1.0 and 1.0 , implying that not much distortion is to be expected (Muthén & Kaplan, 1985). For MANOVA and ANOVA, CBCL, TRF and CITO data were corrected for SES for each child by taking at each age the difference between his/her score and the average score in his/ her SES group, as these scores are associated with SES (Van Beijsterveldt et al., 2005).

As twin data consist of nonindependent observations, one child from each twin pair was selected randomly to be included in the study. Data from the nonselected twins were used in a replication in which the same pattern of results were found (for details, contact the first author). If an effect was found, all analyses were repeated with zygosity as an additional between factor to test if MZ and DZ twins react differently to separation.

Results

Most twins are in the same classroom at school; however, in recent years there has been an increase in the number of twins who attend separate classrooms. In 1988, 72% of the twin pairs at the age of 5 years

were in the same classroom, but by 1998 this rate had dropped to 52%. The decision to separate twins seems to change during their schooling in 37% of the cases: of the 1006 twin pairs who were in the same classroom at the age of 5, 77% reported being together for (most of) the entire school period, 16% being separated, and 7% being partly separated and partly together by the age of 12 years. Of the 500 twin pairs who went to separate classes, 64% reported being separated for (most of) their schooling, 26% reported being together and 9% reported being partly separated, partly together.

Classroom separation at the age of 5 was significantly associated with externalizing problems at age 3, $\chi^2(1) = 19.13$, $p < .01$ and with SES, $\chi^2(1) = 58.96$, $p < .01$. The higher the score on the externalizing scale at age 3, and the higher the SES, the more likely that twins were in separate classrooms at age 5 (see Table 1). Internalizing problems at age 3, $\chi^2(1) = 1.50$, $p = .22$, within-twin pair differences in externalizing problems at age 3, $\chi^2(1) = 1.90$, $p = .17$, and within-twin pair differences in internalizing problems at age 3, $\chi^2(1) = .02$, $p = .89$, did not predict separation.

Short-Term Effects

Table 2 shows average maternal CBCL ratings at ages 3 and 7 and the TRF ratings at age 7. Untransformed and uncorrected mean ratings are given for the separated and nonseparated twins (at age 5). Additionally, ratings are given for MZ and DZ twins separately. MANOVA with repeated measures tested for differences in maternal ratings at the internalizing and the externalizing scale at age 7 between separated and nonseparated twins. Separated twins scored significantly higher on problem behavior than nonseparated twins, $F(2, 4854) = 18.40$, $p < .01$. There was a significant interaction between age of testing and classroom separation, $F(2, 4854) = 7.53$, $p < .01$. Separated twins were more dissimilar from nonseparated twins at age 7 than at age 3. This means that there is a difference between separated and nonseparated twins that cannot be explained by preexisting differences at age 3. Univariate tests showed significant main effects of separation for internalizing, $F(1, 4855) = 18.53$, $p < .01$, and externalizing problems, $F(1, 4855) = 35.50$, $p < .01$. The interaction between age and separation was significant for the internalizing scale only: internalizing $F(1, 4855) = 14.77$, $p < .01$; externalizing $F(1, 4855) = 0.97$, $p = .33$, with an effect size of 0.14 standard deviation. Thus, as a consequence of separation, separated twins at age 7 have more internalizing problems than nonseparated twins.

An extra analysis was carried out to see whether DZ and MZ twins reacted differently to classroom separation. To take preexisting differences in maternal ratings of twins at age 3 into account, the interaction between age of testing, separation and zygosity was assessed. Only when there is an interaction between age of testing, separation and zygosity can it be con-

cluded that zygosity influences the way twins react to separation. No significant difference was found, $F(2, 4852) = 0.88$, $p = .42$. Thus, MZ and DZ twins do not react differently to separation.

The MANOVA carried out to see whether there are differences in teacher ratings at age 7 in separated and nonseparated twins showed that separated twins were rated significantly higher by the teacher on problem behavior at age 7 than the nonseparated twins, $F(2, 1495) = 3.09$, $p = .05$. Univariate analyses showed only a significant difference on internalizing problems; internalizing: $F(1, 1496) = 6.00$, $p = .01$; externalizing: $F(1, 1496) = 1.13$, $p = .29$. An extra analysis performed to test for MZ/DZ differences showed no interaction effect between zygosity and separation, $F(2, 1730) = 0.45$, $p = .64$.

Long-Term Effects

Multinomial regression analysis was carried out to test for preexisting differences between separated and nonseparated twins at school. Results showed that SES, problem behavior at age 3 and within-twin pair differences in internalizing problems at age 3 did not predict separation at school; SES: $\chi^2(2) = 3.24$, $p = .20$; internalizing: $\chi^2(2) = .60$, $p = .74$; externalizing: $\chi^2(2) = 2.71$, $p = .26$; within-twin pair difference internalizing: $\chi^2(2) = 3.46$, $p = .18$. Nevertheless, the data were corrected for SES ratings to maintain uniformity across analyses. Within-twin pair differences at age 3 in externalizing problems predicted separation at school, $\chi^2(2) = 8.34$, $p = .02$.

The untransformed and uncorrected maternal and teacher ratings at age 12 are given in Table 3. Twins in the *partly* group scored highest on the maternal ratings, followed by *separated* and *together* twins consecutively. To test whether these differences could be explained by separation itself, a MANOVA with repeated measures was done. Results of this analysis revealed a significant effect of separation, $F(4, 3294) = 5.92$, $p < .01$, on maternal CBCL ratings. Subsequent univariate testing showed that the main effect was significant for the internalizing, $F(2, 1647) = 10.11$, $p < .01$, and externalizing, $F(2, 1647) = 8.29$, $p < .01$, scales. However, there was no significant interaction effect between age of testing and separation, $F(4, 3294) = 1.17$, $p = .32$, meaning that after controlling for preexisting differences at age 3, the difference between separated and nonseparated twins could not be attributed to separation itself.

On the TRF *separated* twins scored highest on the internalizing and externalizing scale, followed by the *together* and the *partly* group, respectively. A MANOVA performed to test whether these differences were significant revealed there was a main effect of separation at school on TRF ratings at age 12, $F(4, 1646) = 4.25$, $p < .01$. Univariate testing showed this effect was significant for the internalizing, $F(2, 823) = 7.29$, $p < .01$, and the externalizing scale, $F(2, 823) = 9.84$, $p = .02$. Post hoc pair-wise comparisons revealed for the internalizing scale as

Table 3

Separation at School and Mean Untransformed and Uncorrected Maternal CBCL and TRF Ratings at Age 12

Measure	Separated entire schooling	Zygosity	N	M (SD)
Internalizing problems age 12 mother	together	DZ	919	4.17 (4.76)
		MZ	362	3.90 (4.17)
		Total	1281	4.09 (4.60)
	separated	DZ	410	4.45 (4.43)
		MZ	202	4.97 (6.09)
		Total	612	4.62 (5.04)
	partly	DZ	111	5.96 (6.05)
		MZ	49	4.98 (4.72)
		Total	160	5.66 (5.68)
	together	DZ	926	5.60 (5.96)
		MZ	363	5.18 (5.70)
		Total	1289	5.49 (5.89)
Externalizing problems age 12 mother	separated	DZ	420	6.35 (6.40)
		MZ	206	6.78 (7.58)
		Total	626	6.49 (6.81)
	partly	DZ	111	6.09 (5.83)
		MZ	49	6.96 (5.61)
		Total	160	6.36 (5.76)
Internalizing problems age 12 teacher	together	DZ	412	4.23 (5.11)
		MZ	181	3.26 (3.89)
		Total	593	3.93 (4.79)
	separated	DZ	170	5.11 (5.49)
		MZ	80	5.86 (6.68)
		Total	250	5.35 (5.90)
	partly	DZ	47	3.87 (5.42)
		MZ	23	4.30 (6.98)
		Total	70	4.01 (5.93)
	together	DZ	419	4.47 (7.850)
		MZ	183	3.98 (6.03)
		Total	602	4.32 (7.34)
Externalizing problems age 12 teacher	separated	DZ	183	5.51 (7.76)
		MZ	92	6.03 (10.31)
		Total	275	5.69 (8.68)
	partly	DZ	49	3.92 (6.80)
		MZ	27	4.26 (5.56)
		Total	76	4.04 (6.35)

well as the externalizing scale that there was only a significant difference, $p < .05$, between the *together* group and the *separated* group. An extra analysis performed to test whether MZ and DZ twins reacted differently to separation showed no interaction between zygosity and separation, $F(4, 1640) = 1.28$, $p = .28$.

The average score on the CITO was 538.4 ($SD = 8.61$). Twins in the *partly separated* group scored highest ($M = 541.6$, $SD = 5.83$), followed by the *together* ($M = 538.1$, $SD = 8.69$) and *separated*

($M = 537.8$, $SD = 8.95$) groups respectively. Separation had a significant effect on CITO scores, $F(2, 840) = 4.25$, $p = .02$. Post hoc pair-wise comparisons showed that these differences were only significant between the *partly separated* and *together* group, and the *partly* and *separated* group of twins. Thus, there was no difference in academic performance between the separated and nonseparated twins, but the partly separated twins scored higher on academic performance. Additional analyses performed to test whether MZ and DZ twins react differently to separation showed no interaction between CITO-ratings, zygosity and separation, $F(2, 837) = 0.07$, $p = .93$. Thus, MZ and DZ twins do not differ in academic performance as a consequence of separation.

Discussion

Like Tully and colleagues (2004), a difference at age 7 was found between separated and nonseparated twins on the internalizing scale of the TRF. It was also found that twins who were in different classrooms at the age of 5 years generally scored higher on maternal ratings of internalizing and externalizing problems than nonseparated twins. In addition, we found that twins separated for almost their entire schooling scored significantly higher on teacher and mother ratings of internalizing and externalizing problems than nonseparated twins.

As twins had been rated on internalizing and externalizing problems by their mother when they were 3 years old, it was possible to look for preexisting differences in behavior between separated and nonseparated twins. Interestingly, differences in externalizing problems already existed before separation. Externalizing problems predicted separation at age 5 and within-twin pair differences in externalizing problem behavior predicted separation for their entire schooling, but not separation at age 5. This suggests that the decision to separate twins when they go to school is based in part on their externalizing problems at a young age, but not on any internalizing problems at age 3.

When preexisting differences in externalizing problems at age 3 were taken into account, separation of the twins had no significant effect on externalizing problems as rated by the mother at age 7. The significant differences between the separated and nonseparated twins at age 7 on the externalizing scale already existed before separation at age 5 and separation at age 5 had no additional effect on externalizing problems at age 7. A different result was obtained for internalizing problems: twins separated at age 5 had more internalizing problems at age 7 than nonseparated twins, a result that could not be explained by preexisting problems. For maternal ratings of problem behavior at age 12, both for internalizing and externalizing, separated twins did not score higher than nonseparated twins after correction for these problems at age 3. So, the differences we found

at age 12 between twins who were separated or non-separated for almost their entire schooling already existed at age 3. This indicates that separation for the entire schooling has no additional effect on problem behavior at the age of 12. Separation at an early age only seems to have a short-term effect on internalizing problems at age 7.

The finding of Tully and colleagues (2004) that MZ twins suffer more from separation than DZ twins was not replicated in this study. We did not find that MZ and DZ twins reacted to separation in a different way at either age 7 or 12. The study had a large sample, and it is unlikely that a lack of statistical power caused these results. One possible explanation is that the findings regarding the separation of twins in the UK do not generalize to Dutch settings, as the decision to separate twins in both countries is based on different grounds and has different consequences. This interpretation is supported by the observation that Tully and co-workers (2004) found no relationship between familial social class and separation, whereas a relationship was found in this study.

The effect of separation on behavioral, emotional problems and academic performance was studied. A limitation of this study is that the effect of separation on identity formation was not investigated. Identity formation is often given as the major justification to separate a twin pair, as this can be more problematic for twins who are often treated and judged as one of a pair and not as an individual (Akerman & Suurveen, 2003; Geluk & Hol, 2001). The children's own point of view was not taken into account. Twins may experience their separation as positive, as they no longer have to share attention with their co-twin.

Based on the findings of this study, it can be concluded that for behavioral problems at the age of 7 years, it does matter whether twins are separated or not. The separation of twins at school leads to internalizing problem behavior. However, it is important to note that all findings represent small effect sizes. And furthermore, at the age of 12 years, this effect has disappeared. When these last two points are taken into consideration, it seems that it makes no difference whether twins are separated or not. The recommendation that the decision about classroom separation of twins should be based upon what parents think is best for their twins and for themselves, still seems sensible (Geluk & Hol, 2001).

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References

- Achenbach, T. M. (1991a). *Manual for the Child Behavior Checklist/4-18 and 1991 profile*. Burlington, VT: University of Vermont, Department of Psychiatry.
- Achenbach, T. M. (1991b). *Manual for the Teacher's Report Form and 1991 profile*. Burlington, VT: University of Vermont, Department of Psychiatry.
- Achenbach, T. M. (1992). *Manual for the Child Behavior Checklist/2-3 and 1992 profile*. Burlington, VT: University of Vermont, Department of Psychiatry.
- Akerman, B. A., & Suurveen, E. (2003). The cognitive and identity development of twins at 16 years of age: A follow-up study of 32 twin pairs. *Twin Research*, 6, 328-333.
- Bartels, M., Rietveld, M. J., Van Baal, G. C., & Boomsma, D. I. (2002). Heritability of educational achievement in 12-year-olds and the overlap with cognitive ability. *Twin Research*, 5, 544-553.
- Boomsma, D. I. (1998). Twin registers in Europe: An overview. *Twin Research*, 1, 34-51.
- Boomsma, D. I., Orlebeke, J. F., & Van Baal, G. C. (1992). The Dutch Twin Register: Growth data on weight and height. *Behavior Genetics*, 22, 247-251.
- Boomsma, D. I., Vink, J. M., van Beijsterveldt, T. C., de Geus, E. J., Beem, A. L., Mulder, E. J., Derks, E. M., Riese, H., Willemsen, G. A., Bartels, M., van den Berg, M., Kupper, N. H., Polderman, T. J., Posthuma, D., Rietveld, M. J., Stubbe, J. H., Knol, L. I., Stroet, T., & van Baal, G. C. (2002). Netherlands Twin Register: A focus on longitudinal research. *Twin Research*, 5, 401-406.
- Fengler, M., Joung, I., & Mackenbach, J. (1997). Sociaal-demografische kenmerken en gezondheid: Hun relatief belang en onderlinge relaties (Social demographic characteristics and health: Their relative importance and mutual relations). In J. P. Mackenbach & H. Verkleij (Eds.), *Volksgezondheid Toekomst Verkenning 1997, II Gezondheidsverschillen* (pp. 49-67). Maarssen, the Netherlands: Elsevier/De Tijdstroom.
- Geluk, A., & Hol, J. (2001). Samen of apart? Meerlingkinderen naar school, peuterspeelzaal of kinderopvang (Together or Apart? Multiples to school, playground or daycare) [Brochure]. Bergen, the Netherlands: NVOM (Dutch Society for Parents of Multiples).
- Hay, D. A. (2004). Together or apart? *Twin Research*, 7(2), iii-iv.
- Koot, H. M., van den Oord, E. J., Verhulst, F. C., & Boomsma, D. I. (1997). Behavioral and emotional problems in young preschoolers: Cross-cultural testing of the validity of the Child Behavior Checklist/2-3. *Journal of Abnormal Child Psychology*, 25, 183-196.
- Muthén, B., & Kaplan, D. (1985). A comparison of some methodologies for the factor analysis of non-normal Likert variables. *British Journal of Mathematical and Statistical Psychology*, 38, 171-189.
- Rietveld, M. J., Der Valk, J. C., Bongers, I. L., Stroet, T. M., Slagboom, P. E., & Boomsma, D. I. (2000). Zygosity diagnosis in young twins by parental report. *Twin Research*, 3, 134-141.

- Statistics Netherlands, Centraal Bureau voor de Statistiek. (n.d.). *Statline Webselector*. Retrieved November, 2004, from <http://statline.cbs.nl/StatWeb>
- Tully, L. A., Moffitt, T. E., Caspi, A., Taylor, A., Kiernan, H., & Andreou, P. (2004). What effect does classroom separation have on twins' behavior, progress at school, and reading abilities? *Twin Research*, 7, 115–124.
- Van Beijsterveldt, C. E. M., Hudziak, J. J., & Boomsma, D. I. (2005). Short- and long-term effects of child care on problem behaviors in a Dutch sample of twins. *Twin Research and Human Genetics*, 8, 250–258.
- Verhulst, F. C., Van der Ende, J., & Koot, H. M. (1996). *Handleiding voor de CBCL/4–18* (Manual for the CBCL/ 4–18). Rotterdam, the Netherlands: Department of Child and Adolescent Psychiatry, Sophia Children's Hospital/Academic Hospital Rotterdam/Erasmus University Rotterdam.
- Verhulst, F. C., Van der Ende, J., & Koot, H. M. (1997). *Handleiding voor de teacher's report form (TRF; Manual for the teacher's report form [TRF])*. Rotterdam, the Netherlands: Department of Child and Adolescent Psychiatry, Sophia Children's Hospital/Academic Hospital Rotterdam/Erasmus University Rotterdam.
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